

**UNITED STATES PATENT AND TRADEMARK OFFICE**  
**CERTIFICATE OF CORRECTION**

Page 1 of 8

PATENT NO. : 7,331,012

APPLICATION NO. : 10/634,723

ISSUE DATE : February 12, 2008

INVENTOR(S) : Bane Vasic et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**At col. 6, lines 28–31, please delete:**

" 0\*(1111111111111111)+1\*(0000000011111111)+1\*(00001110001111)+0\*(0011001100110011)+0\*(0000000000001111)+0\*(0000000000110011)+0\*(0000000001010101)=(0000111111110000). "

**and insert therefore:**

-- 0\*(1111111111111111)+1\*(0000000011111111)+1\*(00001110001111)+0\*(0011001100110011)+0\*(01010101010101)+0\*(0000000000001111)+0\*(000000000110011)+0\*(0000000001010101)=(0000111111110000). --

**At col. 6, lines 28–31, please delete:**

"FIG. 3 illustrates a communication circuit 10 according to the present invention. The communication circuit 10 includes an RM-encoder 12, a partial-response channel 14, and a Reed-Muller partial response decoder 16 (RM-PR 16). For simplicity, a transmission of a single codeword *m* is shown, though the same principle of operation holds for every message word transmitted. As shown, codeword *m* is input into the RM encoder 12, which generates an RM-encoded codeword *x*. RM-encoded codeword *x* is transmitted over the Partial-Response (PR) channel 14, which tends to introduce noise to the codeword *x* such that the received codeword *y* contains unknown errors. As shown, the received codeword *y* is input into the RM-PR decoder 16, which produces an output decoded codeword."

**and insert therefore:**

-- FIG. 3 illustrates a communication circuit 10 according to the present invention. The communication circuit 10 includes an RM-encoder 12, a partial-response channel 14, and a Reed-Muller partial response decoder 16 (RM-PR 16). For simplicity, a transmission of a single codeword *m* is shown, though the same principle of operation holds for every message word transmitted. As shown, codeword *m* is input into the RM encoder 12, which generates an RM-encoded codeword *x*. RM-encoded codeword *x* is transmitted over the Partial-Response (PR) channel 14, which tends to introduce noise to the codeword *x* such that the received codeword *y* contains unknown errors. As shown, the received codeword *y* is input into the RM-PR decoder 16, which produces an output decoded codeword.

--

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**At col. 9, lines 15–16, please delete:**

" The interleaver 18 orders re-orders the RM-encoded codeword  $x$  prior to passing the codeword  $x$  to the partial-response channel 14. "

**and insert therefore:**

-- The interleaver 18 randomly re-orders the RM-encoded codeword  $x$  prior to passing the codeword  $x$  to the partial-response channel 14. --

**At col. 10, lines 42–46, please delete:**

" The BCJR or SOVA device 20A has no initial reliability vector  $\lambda(\hat{m})$  associated with the received code word  $y$ , so the second input of the BCJR or SOVA device 20A is a reliability vector  $\lambda(\hat{x})$  of value zero, providing no indication of reliability. "

**and insert therefore:**

-- The BCJR or SOVA device 20A has no initial reliability vector  $\lambda(\hat{x})$  associated with the received code word  $y$ , so the second input of the BCJR or SOVA device 20A is a reliability vector  $\lambda(\hat{x})$  of value zero, providing no indication of reliability. --

**At col. 11, lines 34–35, please delete:**

" corresponding to  $G_j$  (with) message word bits  $x_s^{(j)}$  having index s such that "

**and insert therefore:**

-- corresponding to  $G_j$  (with) message word bits  $x_s^{(j)}$  having index s such that --

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**At col. 11, lines 50–57, please delete:**

" In each array  $P_s$ , each column shows the locations of the code bits to be added together to give an estimation of the message bit  $x_s$ . This addition is modulo-2 addition. In the hard-coding version, the message bit is determined by a majority vote among all  $2^{m-j}$  estimations, (as described above), and the received code vector is updated according to the relation  $y \leftarrow y \times x^{(j)} G_j$ , and then passed to the next decoding step (step  $j \times 1$ ). "

**and insert therefore:**

-- In each array  $P_s$ , each column shows the locations of the code bits to be added together to give an estimation of the message bit  $x_s^{(j)}$ . This addition is modulo-2 addition. In the hard-coding version, the message bit is determined by a majority vote among all  $2^{m-j}$  estimations, (as described above), and the received code vector is updated according to the relation  $y \leftarrow y + x^{(j)} G_j$ , and then passed to the next decoding step (step  $j+1$ ). --

**At col. 11, lines 62–64, please delete:**

"  $LLR(b_s) = \log \left( \frac{\text{Probability}(b_s = +1 | y)}{\text{Probability}(b_s = -1 | y)} \right)$  "

**and insert therefore:**

--  $LLR(b_s) = \log \left( \frac{\text{Probability}(b_s = +1 / y)}{\text{Probability}(b_s = -1 / y)} \right)$  --

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**At col. 12, lines 5–32, please delete:**

$$" \quad \mu(\hat{m}_s^{i,j}) = -S_s^{i,j} \cdot \log \left\{ -\tanh \left( \frac{A_s^{i,j}}{2} \right) \right\} \quad (1)$$

$$S_s^{i,j} = \prod_i \text{sign}\{u(\hat{x}_l^{i,j,s})\} \quad (2)$$

where  $\mu(\hat{x}_l^{i,j,k})$  is the LLR of the expression for the s-th message bit from the i-th equation in the j-th level, and where

$$A_s^{i,j} = \sum_l \log \left| \tanh \left( \frac{\mu(\hat{x}_l^{i,j,s})}{2} \right) \right|. \quad (3)$$

and "

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**At col. 12, lines 5–32, please insert therefore:**

$$-- \quad \mu(\hat{m}_s^{i,j}) = -S_s^{i,j} \cdot \log \left\{ -\tanh \left( \frac{A_s^{i,j}}{2} \right) \right\} \quad (1)$$

where  $\mu(\hat{x}_l^{i,j,s})$  is the LLR of the expression for the s-th message bit from the i-th equation in the j-th level, and where

$$S_s^{i,j} = \prod_l \text{sign}\{\mu(\hat{x}_l^{i,j,s})\} \quad (2)$$

and

$$A_s^{i,j} = \sum_l \log \left| \tanh \left( \frac{\mu(\hat{x}_l^{i,j,s})}{2} \right) \right|. \quad (3) --$$

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INVENTOR(S) : Bane Vasic et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**At col. 12, lines 56–63, please delete:**

" In the hard decoding version (Reed algorithm), a message bit is determined by a majority vote, and the received code vector is updated using the expression  $y \leftarrow y \times x^{(j)} G_j$  given above, and then passed to the next decoding step. In the soft decoding version, prior to advancing to the next row of the decoder **16**, the updated message bit likelihoods must be converted to the code bit likelihoods. This conversion is performed based on the submatrix  $G_j$ . "

**and insert therefore:**

-- In the hard decoding version (Reed algorithm), a message bit is determined by a majority vote, and the received code vector is updated using the expression  $y \leftarrow y + x^{(j)} G_j$  given above, and then passed to the next decoding step. In the soft decoding version, prior to advancing to the next row of the decoder **16**, the updated message bit likelihoods must be converted to the code bit likelihoods. This conversion is performed based on the submatrix  $G_j$ . --

**At col. 13, lines 26–27, please delete:**

" Suppose that the nonzero positions of the l-th column of  $G_j$  are given by the set  $\{l_1 \dots l_t\}$  where "

**and insert therefore:**

-- Suppose that the nonzero positions of the l-th column of  $G_j$  are given by the set  $\{l_1 \dots l_t\}$  where --

**At col. 13, lines 63–65, please delete:** "  $\lambda(\hat{x}_l) = \left[ \prod_j \text{sign}\{u(\hat{m}_{lj})\} \right] \cdot \min_j \{|\mu(m_{lj})|\}$  "

**and insert therefore:** --  $\lambda(\hat{x}_l) = \left[ \prod_j \text{sign}\{\mu(\hat{m}_{lj})\} \right] \cdot \min_j \{|\mu(m_{lj})|\}$  --

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

$$m_{10} = c_0 + c_1 + c_{2+c3}$$

**At col. 14, lines 46–56, please delete:** "  $m_{10} = c_4 + c_5 + c_{6+c7}$  "

$$m_{10} = c_8 + c_9 + c_{10+c11}$$

$$m_{10} = c_{12} + c_{13} + c_{14+c15}$$

$$m_{10} = c_0 + c_1 + c_2 + c_3$$

**and insert therefore: --**  $m_{10} = c_4 + c_5 + c_6 + c_7$  --

$$m_{10} = c_8 + c_9 + c_{10} + c_{11}$$

$$m_{10} = c_{12} + c_{13} + c_{14} + c_{15}$$

**At col. 14, lines 63–66, please delete:** "  $P_{10} = \begin{bmatrix} 0 & 4 & 8 & 12 \\ 1 & 5 & 9 & 13 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \end{bmatrix}$  "

**and insert therefore: --**  $P_{10} = \begin{bmatrix} 0 & 4 & 8 & 12 \\ 1 & 5 & 9 & 13 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \end{bmatrix}$  --

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**At col. 15, lines 10–15, please delete:** "  $P_1 = \begin{bmatrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 \end{bmatrix}$  "

**and insert therefore:** --  $P_1 = \begin{bmatrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 \end{bmatrix}$

$P_0 = [0 \ 1 \ 2 \ 3 \ 4 \ 5 \ 6 \ 7 \ 8 \ 9 \ 10 \ 11 \ 12 \ 13 \ 14 \ 15] --$

$P_5 = \begin{bmatrix} 0 & 4 & 8 & 12 \\ 1 & 5 & 9 & 12 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \end{bmatrix}$  "

**At col. 15, lines 20–30, please delete:** "  $P_5 = \begin{bmatrix} 0 & 4 & 8 & 12 \\ 1 & 5 & 9 & 13 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \end{bmatrix}$  "

**and insert therefore:** --  $P_5 = \begin{bmatrix} 0 & 4 & 8 & 12 \\ 1 & 5 & 9 & 13 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \end{bmatrix} --$

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